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# High Rise Buildings in Nigeria: Prospects and Challenges

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***Abstract:***
*The rapid urbanization and population growth in Nigeria have led to an increased demand for high-rise buildings to accommodate the expanding population and optimize land use. This research paper explores the prospects and challenges associated with high-rise buildings in Nigeria. It examines the potential benefits of high-rise construction, such as increased housing capacity and economic growth, while also addressing the significant challenges, including infrastructural limitations, regulatory frameworks, and environmental sustainability. Several factors such as lack of sufficient public electricity/water supply, regulatory bottlenecks, design challenges, social management problems, non-regular structural integrity checks, lack of the required expertise in the built environment, dynamic governmental policies, etc have been identified as the major challenges affecting the development of these vertical structures in Nigeria. Also, the effect of the window to wall ratio (WWR) on the energy utilization efficiency in these building structures were studied. Results showed that better energy savings were recorded in these buildings when the WWR was minimal. Through a comprehensive analysis of existing literature, this paper highlights the key factors that impact the successful development of high-rise buildings in Nigeria and provides recommendations for future development and policy implementation.*

***Keywords****: Buildings, challenges, development, prospects, sustainability.*

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## I. Introduction

High-rise buildings have become a prominent feature of urban landscapes worldwide, and Nigeria is no exception to this trend. The country's rapid urbanization and population growth have created a pressing need for high-rise construction to meet the rising demand for housing and optimize land use. However, the development of high-rise buildings in Nigeria brings forth both prospects and challenges that need to be carefully examined. [1,2].

The objective of this research paper is to explore the prospects and challenges associated with high-rise buildings in Nigeria. By conducting a comprehensive analysis of existing literature, this study aims to shed light on the potential benefits of high-rise construction and the significant hurdles that must be overcome for successful development. Understanding these factors is crucial for policymakers, urban planners, and developers to make informed decisions regarding high-rise construction in Nigeria. [3]

High-rise buildings have gradually emerged as an integral part of Nigeria's urban landscape, transforming city skylines and shaping the built environment. The development of high-rise buildings in Nigeria has been influenced by various factors, including historical, social, economic, and demographic forces. [4]

Historically, the construction of tall buildings in Nigeria can be traced back to the colonial era, when the country was under British rule.[5]. During this period, the construction of high-rise structures was primarily limited to major urban centers like Lagos, where British influence was strongest. Notable examples of early high-rise buildings include the Cocoa House in Ibadan, completed in 1965, which was the tallest building in West Africa at the time. These structures were often built to serve administrative or commercial purposes. [6]. In recent decades, Nigeria has experienced rapid urbanization and population growth. The urban population has been increasing at an unprecedented rate, fueled by rural-urban migration, natural population growth, and economic opportunities in urban areas. As a result, the demand for housing and infrastructure has skyrocketed, leading to the need for high-rise buildings as a solution to the limited availability of land in urban areas.

**Table 1**: List of investigated high-rise buildings in Nigeria [3]

| S/N | Building | Height (m) | Floors | Year of completion | Location |
|---|---|---|---|---|---|
| 1. | NECOM House | 160 | 32 | 1979 | Lagos |
| 2. | Champagne Pearl Tower | 134 | 34 | 2017 | Lagos |
| 3. | Union Bank Building | 124 | 28 | 1991 | Lagos |
| 4. | WTC Tower 2 | 120 | 25 | 2016 | Abuja |
| 5. | Eko Tower II | 118 | 27 | 2016 | Lagos |
| 6. | Black Pearl Tower | 112 | 25 | 2017 | Lagos |
| 7. | 4 Bourdillon | 110 | 25 | 2020 | Lagos |
| 8. | WTC Tower 1 | 110 | 30 | 2016 | Abuja |
| 9. | Dakkada Tower | 108.8 | 21 | 2020 | Uyo |
| 10. | Cocoa House | 105 | 26 | 1965 | Ibadan |

The concentration of economic activities in urban centers, such as Lagos, Abuja, and Port Harcourt, has further accelerated the demand for high-rise buildings.[7]. These cities serve as major business hubs, attracting local and international investments. The growth of industries, commerce, and services has generated a need for office spaces, commercial facilities, and accommodations, which high-rise buildings can provide efficiently.

**Prospects of High-Rise Buildings in Nigeria**

High-rise buildings offer several prospects and potential benefits for Nigeria, addressing the challenges of rapid urbanization and population growth [7]. This section explores these prospects, highlighting the positive impacts that high-rise buildings can have on various aspects of urban development in the country.

*1. Increased Housing Capacity:*

One of the primary prospects of high-rise buildings in Nigeria is the ability to accommodate a larger number of residents within limited land space[6,7]. Vertical development allows for the construction of multi-story residential complexes, increasing housing capacity and providing affordable housing options. This is particularly crucial in densely populated urban areas, where land availability is scarce.*2. Optimized Land Use:*High-rise buildings enable optimal utilization of land resources by maximizing the vertical dimension. By constructing vertically rather than horizontally, high-rise buildings minimize the urban sprawl and preserve valuable land for other purposes such as green spaces, parks, and infrastructure development [8]. This approach promotes sustainable urbanplanning and efficient land management.*3. Economic Growth:*The development of high-rise buildings can contribute to economic growth in several ways. Firstly, it stimulates the construction industry, creating employment opportunities and generating income [4,6]. Secondly, high-rise buildings attract local and foreign investments, especially in commercial and business districts, fostering economic activities and generating revenue. Additionally, these buildings can house offices, retail spaces, and other commercial establishments, enhancing business opportunities and promoting entrepreneurship.

*4. Sustainable Urban Development:*High-rise buildings have the potential to contribute to sustainable urban development in Nigeria [4]. With appropriate design and construction practices, they can incorporate sustainable features such as energy-efficient systems, water management strategies, and green building technologies. Vertical development also encourages compact urban forms, reducing the need for long-distance commuting and promoting walkability. By concentrating development in urban centers, high-rise buildings support efficient transportation networks and reduce the environmental impacts associated with urban sprawl.

**Fig. 1**: Dakkada Towers, Uyo [13]

**Fig. 2**: NECOM House, Lagos [13]

*5. Smart Technologies:*High rise buildings incorporate smart technologies to include: air handling units, pressurized air blowers for smoke detection and removal, information networking systems, effluent treatment systems, cooling towers, fire water sprinklers, energy saving and monitoring systems, advanced lighting control systems and computer aided building management systems which are used to create the enabling working environment in the building.

**2.1 Challenges Faced by High-Rise Buildings in Nigeria:**

*2.1.1 Infrastructural Challenges:*

a) Design Challenges: High rise building design in Nigeria can become very challenging sometimes due to certain factors; soil investigation activities and natural challenges such as wind effects and storm water evacuation. Extensive soil investigation activities are usually carried out when designing these structures in order to ensure that the foundation of the building is properly designed. In some cases where the California Bearing Ratio (CBR) may have issues, piles are usually sunk into the earth and a raft foundation is sometimes used. Also, the building must be designed to counter certain natural challenges viz wind and earthquakes and elaborate wind load calculations need to be carried out. These factors make the design of high-rise buildings in Nigeria to become a very challenging process.

b) Power Supply: The provision of reliable and uninterrupted power supply is essential for high-rise buildings. However, Nigeria faces challenges in power generation, distribution, and frequent power outages[8].. High-rise buildings require substantial electricity for lighting, elevators, air conditioning, and other services, making a consistent power supply crucial for their functionality.

c) Lack of Expertise: Lack of competent skilled manpower and the proliferation of quacks in the Nigerian building industry also pose a huge challenge to the development of high-rise buildings in the country [6,8]. Most professionals in the built environment do not have the required expertise to carry out high rise building construction work and most building designs are usually error prone which lead to several bureaucratic challenges when securing approval for construction.

d) Water Management: Adequate water supply and efficient water management systems are vital for high-rise buildings. However, water scarcity, inadequate infrastructure for water distribution, and ineffective wastewater management pose significant challenges. The demand for water in high-rise buildings is high, requiring robust systems for supply, storage, and wastewater treatment.

e) Transportation Networks: Inadequate transportation infrastructure, including roads, public transportation systems, and parking facilities, pose challenges for high-rise buildings [7]. The existing transportation networks may struggle to accommodate the increased population density and traffic associated with high-rise developments, leading to congestion and decreased accessibility.

*2.1.2 Regulatory Frameworks and Bureaucratic Hurdles:*

Navigating the regulatory frameworks and bureaucratic processes in Nigeria can be complex and time-consuming, hindering the development of high-rise buildings [8]. Delays in obtaining permits and approvals, unclear guidelines, and inconsistent enforcement of regulations can create challenges for developers. Streamlining and improving the regulatory processes are necessary to facilitate the development of high-rise buildings.

*2.1.3 Environmental Challenges:*

a) Waste Management: High-rise buildings generate significant amounts of waste, including solid waste, wastewater, and construction debris. Proper waste management systems, including recycling, waste segregation, and efficient disposal methods, are crucial to minimize the environmental impact. However, inadequate waste management infrastructure and practices pose challenges for high-rise buildings in Nigeria.

b) Energy Consumption: High-rise buildings consume substantial amounts of energy for lighting, heating, ventilation, and air conditioning (HVAC) systems, resulting in high carbon emissions [15,16]. Energy-efficient design, renewable energy integration, and the adoption of sustainable technologies are necessary to mitigate the environmental impact. However, challenges in accessing clean and affordable energy sources hinder the implementation of sustainable energy solutions.

c) Environmental Impact at the Construction Stage: The construction of high-rise buildings usually has a tremendous impact on the environment. For instance, drilling piles into the ground when constructing these structures can cause vibrations and soil movements. Soil deformations due to pile driving, and the excess pore pressures generated due to undrained deformation, can influence the performance of nearby foundations and may cause damage to adjacent structures [8].

*2.1.4 Social Management Challenges*: Community problems such as unrest and challenges with host communities also hamper the development of high-rise buildings in Nigeria. Certain communities become very restive with property developers and project managers due to certain vested interests which they may have and this may either slow down or lead to a discontinuance of the building project.

*2.1.5 Successive Governments:* Lack of continuity of governmental policies as a result of change of government may also hinder the actualization of some high-rise building projects. Successive governments in Nigeria tend to shy away from the projects initiated by the previous government as this poses a serious challenge in the building industry in the country. Addressing these challenges requires a holistic approach involving collaboration between the government, urban planners, developers, and other stakeholders. Strategies such as improving transportation infrastructure, expanding power generation capacity, upgrading water management systems, enhancing regulatory frameworks, and promoting sustainable design and construction practices can help overcome these challenges.In conclusion, the challenges faced by high-rise buildings in Nigeria encompass infrastructural limitations, regulatory frameworks, and environmental considerations. Overcoming these challenges is crucial for realizing the prospects and reaping the benefits of high-rise construction. By addressing these issues, Nigeria can create an enabling environment for sustainable and successful high-rise development, contributing to urban growth and improved quality of life.

**Fig. 3**: Eko Pearl Towers, Lagos [13].

## 3.0 Methodology

This research employed a three-stage methodology: literature survey, questionnaire survey and visual evaluation. These were conducted with various professionals in the built environment in Nigeria to include; Site Engineers, Office Engineers, Project Managers and operation managers to discover factors affecting the development of high-rise buildings in Nigeria. The literature survey was aimed at highlighting the various challenges involved during the pre-construction, construction and post-construction stages of these high-rise structures. However, [8] had identified the following factors: Absence of regulation for high-rise construction and maintenance, lack of domestic expertise, zero public supply of electricity and water among others, as the key challenges in this regard. Therefore, these surveys sought to determine the high-rise building infrastructure management experts' views on the challenges and better ways of managing them. The visual evaluation involved a physical inspection of some selected high-rise buildings in Abuja, Lagos and Uyo which are all major cities in Nigeria to determine their current status so that they can be compared to international norms. Some of the issues that were investigated include maintenance, functionality, emergency preparedness, electricity, and so forth. The collected data will be analyzed using both descriptive and comparative analytical methods. Five (5) high rise buildings, located within the research areas was selected for this analysis, they include: A - Dakkada Towers (Uyo), B - Four points by Sheraton Hotel (Uyo), C - NECOM House (Lagos), D – PTDF Towers (Abuja) and E - Champagne Pearl Tower (Lagos).

**Table 2**: Workability of building systems in some high-rise buildings in Nigeria.

| **Building Systems** | **HIGH-RISE BUILDINGS** | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| Fire, life and safety system | ✓ | ✓ | ✓ | ✓ | ✓ |
| HVAC System | ✓ | ✓ | ✓ | ✓ | ✓ |
| Effluent discharge system | ✓ | ↷ | ✓ | ✓ | ✓ |
| Water supply system | ✓ | ✓ | ✓ | ✓ | ✓ |
| Lift and Escalator System | ✓ | ✓ | ✓ | ✓ | ✓ |
| Electrical systems | ✓ | ✓ | ✓ | ✓ | ✓ |
| Emergency &Evacuation system | ✓ | ✓ | ↷ | | ⊗ |
| Building Management System (BMS) | ✓ | ↷ | ⊗ | ✓ ↷ | ✓ |
| Security Systems | ✓ | ✓ | ✓ | ✓ | ✓ |
| Energy Saving system | ✓ | ✓ | | | ✓ |
| Utilities | ✓ | ✓ | ✓ ⊗ | ✓ ⊗ | ✓ |
| Storm Water Management | ✓ | ✓ | ↷ | ✓ | ✓ |
| Power plant/generator backup for energy management system | ✓ | ✓ | ✓ | ✓ | ✓ |

Legend: ✓- Functional - Available but non-functional ↷ - Not available ⊗

### *3.1 Analysis and Ranking of High-rise Building Development factors*

The factors were ranked according to their significance and the level of challenge in which they pose in the development of high-rise buildings in Nigeria. A severity index (S.I) computation model [9] is used for ranking these challenges/factors according to their significance as stated by [8]. Mathematically, the S.I is given by:

$$S.I = (\sum_{i=1}^{3} wi \times fi) \times \frac{100}{n} \quad (1)$$

Where i represents the ratings 1 – 3, $f_i$ – frequency of the response, n, the total number of responses and $w_i$the weights for each rating. The ratings 1 – 3 are used to denote the severity level as follows: 1 – not significant, 2 – moderately significant, 3 – highly significant. The summary of findings regarding the severity index of these challenges are presented in the subsequent headings of this paper.

### *3.2 Energy Utilization in Highrise Buildings in Nigeria*

Enormous amounts of energy resources are being utilized as a result of economic development, population growth, globalization, and rising living standards in developing nations [10, 11]. According to estimates from the Energy International Agency, global energy consumption has climbed by over 70% during the 1980s and by roughly 50% over the last 20 years. Energy consumption in developing nations like Nigeria

will rise by 32% until 2030, per present patterns [12].The world uses energy in a variety of sectors, including construction, transportation, and industry. According to statistics, buildings account for a large portion of energy use [12]. Industrial, transportation, and building sectors each consume about 30%, 28%, and 42% of total energy consumption. Additionally, building usage has a big impact on energy consumption accounting for about 20% of the total energy consumption globally. Energy consumption is a major challenge in the construction and development of high-rise buildings in Nigeria. Energy-efficient design, renewable energy integration, and the adoption of sustainable technologies are necessary to mitigate this challenge.

The first stage of energy efficiency, known as energy saving, entails a set of creative architectural, structural, and engineering measures to cut back on energy use while maintaining a comfortable microclimate inside the building [13]. These measures include reduced lighting, heating, ventilation, air conditioning, and elevator operation. It is well known that high-rise buildings need roughly 70% of their energy for heating, ventilation, and air conditioning (HVAC), 20% for lighting, and 10% for elevator maintenance [14]. The increase in urban energy consumption as a result of urbanization determines the applicability of this direction. According to current figures, 40% of all fuel mined worldwide is now used to power buildings [14].

*3.2.1 Energy Utilization Model for Highrise Building Infrastructure*

The following linear model [17] can be used to represent the energy utilization in a high-rise building:

$$E = \mu(h) + \varepsilon \tag{2}$$

where $E$ is the energy use, $h$ is the independent variable and $\varepsilon$ is the random error. In a high-rise building, the variation of $E$ with hour of day $h$ is periodic, $\mu(h)$ can therefore be represented by a Fourier series.

$$E_h = \beta_0 + \sum_{k=1}^{l}\left(a_k \sin\frac{2\pi h}{P} + \beta_k \cos\frac{2\pi h}{P}\right) + \varepsilon_h \qquad -\infty < h < +\infty \tag{3}$$

where $E_h$ is the energy use at hour $h$, $a_k$ and $\beta_k$ are the coefficients of kth sine and cosine frequencies and P is the period for $k^{th}$ frequency. When data has both annual and diurnal periodicity, one Fourier series each for the annual cycle and the diurnal cycle appears in the model:

$$E_{d,h} = \beta_0 + \sum_{x=1}^{n}\left(a_x \sin\frac{2\pi h}{P} + \beta_x \cos\frac{2\pi h}{P}\right) + \sum_{y=1}^{l}\left(\gamma_y \sin\frac{2\pi h}{P} + \delta_y \cos\frac{2\pi h}{P}\right) + \varepsilon_{d,h} \tag{4}$$

where the first Fourier series with subscript x represents the annual periodicity and second Fourier series with subscript y represents the diurnal periodicity in the right-hand side.

Choosing the day of the year and the hour of the day as the independent variable to represents both the annual and diurnal variation of energy utilization, the model equation now becomes:

$$E_{d,h} = \beta_0 + \sum_{x=1}^{182}\left(a_x \sin\frac{2\pi h}{P} + \beta_x \cos\frac{2\pi h}{P}\right) + E_h = \beta_0 + \sum_{k=1}^{11}\left(a_k \sin\frac{2\pi h}{P} + \beta_k \cos\frac{2\pi h}{P}\right) \tag{5}$$

where the periods are defined as follows:

$$P_x = \frac{365}{x} \qquad x = 1,2,3,\ldots,182. \tag{6}$$

$$P_y = \frac{24}{y} \qquad y = 1,2,3,\ldots,11. \tag{7}$$

*3.2.2 Highrise Building Energy Simulation*

Analyzing the effects of Energy Conservation Measures (ECMs) and their intricate relationships involves using building simulation [15]. One of the most powerful analyses/analytical techniques in the world is computational simulation. As a result, the major methodology for this analysis is the building simulation approach using the eQUEST simulation engine. It was important to choose a model or case to serve as the major base of the research in order to examine and test the variables of the investigation. Using this model, the behavior and impact of variables were assessed. Normalized Mean Bias Error (NMBE) and Coefficient of Variation of Root Mean Square Error CV(RMSE) values were used to validate the model. ASHRAE Guidelines, Federal Energy Management Program (FEMP), and International Performance Measurement and Verification Protocol (IPMVP) use CV(RMSE) with NMBE to verify the accuracy of the models [16]. The NMBE and CV(RMSE) were calculated using the equation given below:

$$NMBE = \frac{1}{Ai}\frac{\Sigma(Ai-Si)}{n} \tag{8}$$

$$CV(RMSE) = \frac{1}{Ai}\sqrt{\frac{\Sigma(Ai-Si)}{n}} \tag{9}$$

Where: Ai = mean value

Si = predicted value

n = number of data points

The goal of this analysis was to determine the external shell components of official high-rise structures that consumed the least amount of energy. Therefore, an official high-rise building with all of its inherent qualities defined served as the research's fundamental model. In this case, the PTDF Towers in Abuja and the Dakkada Tower in Uyo, Akwa Ibom State, Nigeria was used as the research models. The complex qualities of this structures were divided into two primary categories; structural architectural characteristics and facility characteristics in order to make them easier to understand. A factor known as the Window-to-wall (WWR) ratio has been discovered [14] to be directly related to the energy consumption in high-rise buildings. Therefore, this study analyses the energy consumption in high-rise buildings in Nigeria under various climatic conditions in the two locations: Abuja and Uyo, by studying the energy consumed for HVAC, Lighting, Elevator maintenance in these buildings using the WWR.

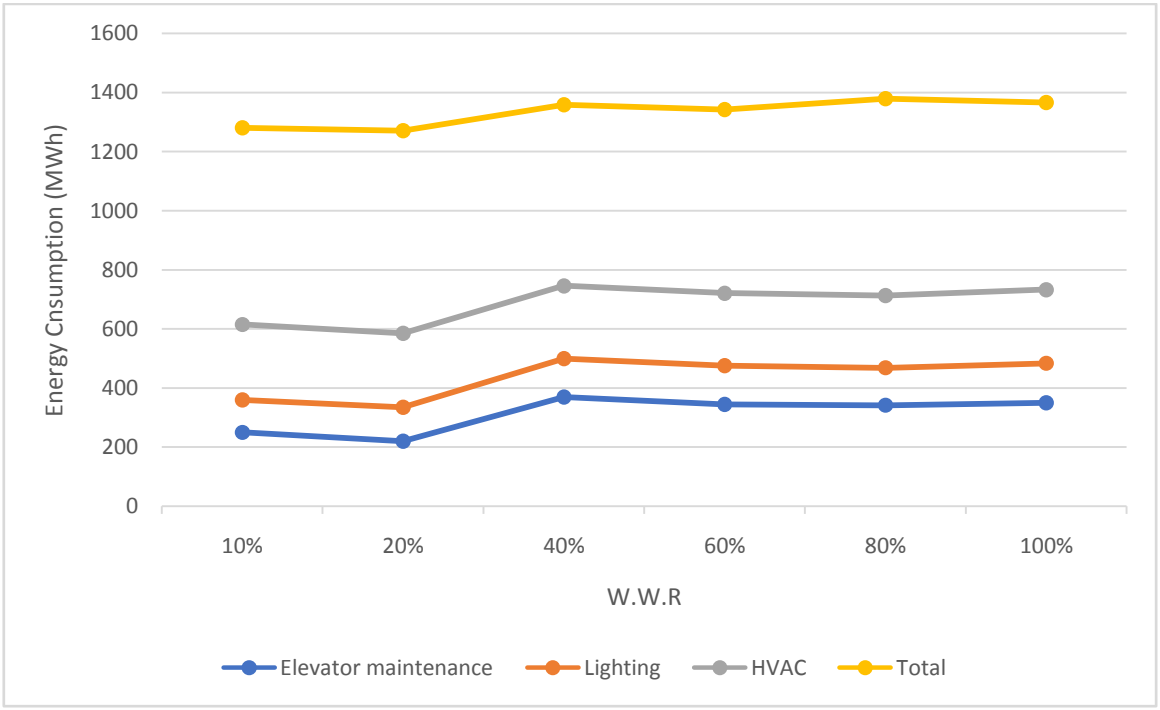


**Fig. 4**: High-rise Building Energy Consumption in Abuja.

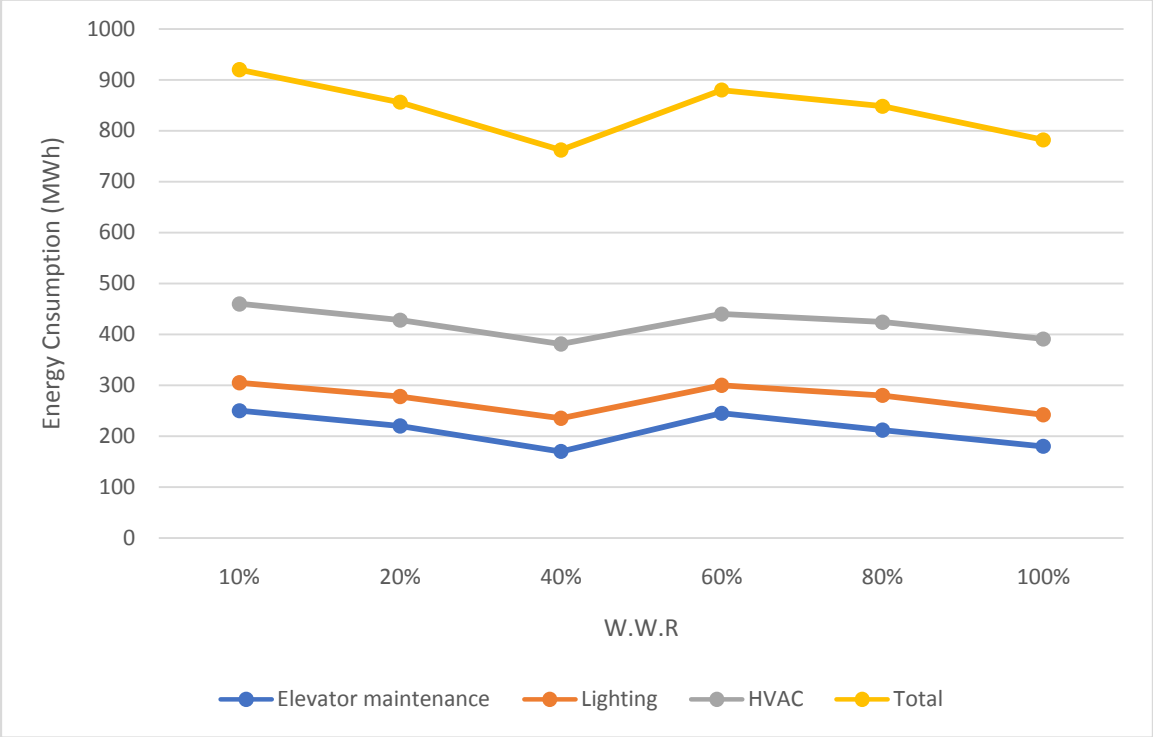


**Fig. 5**: High-rise Building Energy Consumption in Uyo.

*3.2.3 Energy Efficiency in Highrise Building Water Supply Systems*

The potential energy needed at the demand sites is what determines the energy efficiency of a water supply system in high-rise buildings, which can be calculated using the system heights, pipe friction, and allowed pressure head as follows:

$$\alpha = \frac{Eout}{Epump} \quad (10)$$

where $E_{out}$is the potential energy required at the demand locations and $E_{pump}$is the pumping energy of the supply system.

$$E_{out} = \rho g \sum_{i=1}^{n} vi.hi \quad (11)$$

$$E_{pump} = \frac{\rho g \sum_{i=1}^{n} vi.hi + Ho + Hf}{\acute{\eta}} \quad (12)$$

$$H_f = f\frac{u2}{2gd} L_e \quad (13)$$

where $E_{pump}$is the pumping power of lifting water from the reservoir, ή is the design overall transmission efficiency, h is the difference in height between the reservoir outlet and the demand location,Ho is the desired minimum water pressure head assumed at the inlet to the reservoir, $H_f$ is the friction head required in the up-feed water pipe, $f$ is the friction factor and $v$ is the flow velocity.

## IV. Results and discussion

*4.1 Energy Efficiency Analysis in Highrise Buildings in Nigeria*

This study analyzed the Energy utilization efficiency which is a major challenge in the development of high-rise buildings in Nigeria using a building parameter known as the window to wall ratio (W.W.R). The analysis which was carried out using the eQUEST building energy modelling software showed that Energy utilization varied between the two study locations as a result of the different climatic conditions in these regions. For Abuja, the highest energy utilization rate was observed at 80% W.W.R. Also, the least energy utilization was observed at 40% W.W.R for high-rise buildings in Uyo as shown in Fig. 5. Considering the total energy consumption or utilization rate in the two locations; at 80% W.W.R about 1100 MWh of energy was consumed which was the highest, also the lowest energy consumption rate occurred at 20% W.W.R. Therefore, since it is desirable to design high-rise buildings for efficient energy utilization so as to reduce operational costs; efforts should be made to reduce the W.W.R of these structures so as to result in better energy savings.

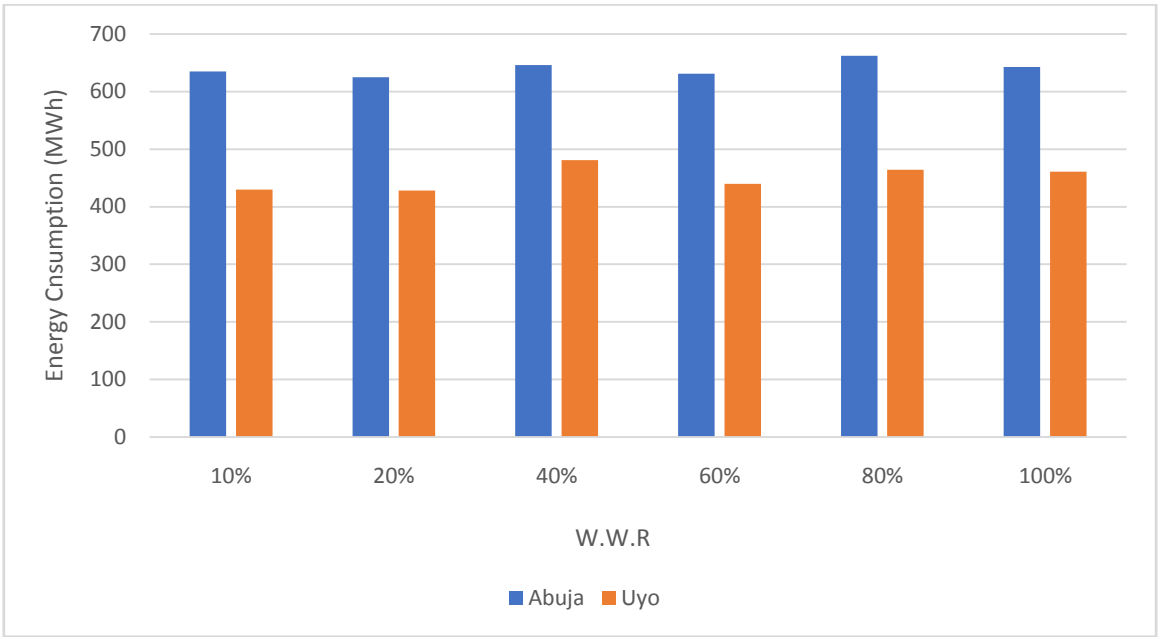


**Fig. 6**: Total Energy consumed in Abuja and Uyo

*4.2 Major Challenges of high-rise buildings construction in Nigeria*

Experts within the built environment were also questioned on the challenges faced by high rise building constructions in the country and the results of this analysis performed is highlighted. The experts included Project Managers (PM), Site Engineers (SE), Office Engineers (OE) and Resident Engineers. Fig. 7 shows the major technical challenges of high-rise building construction in Nigeria.

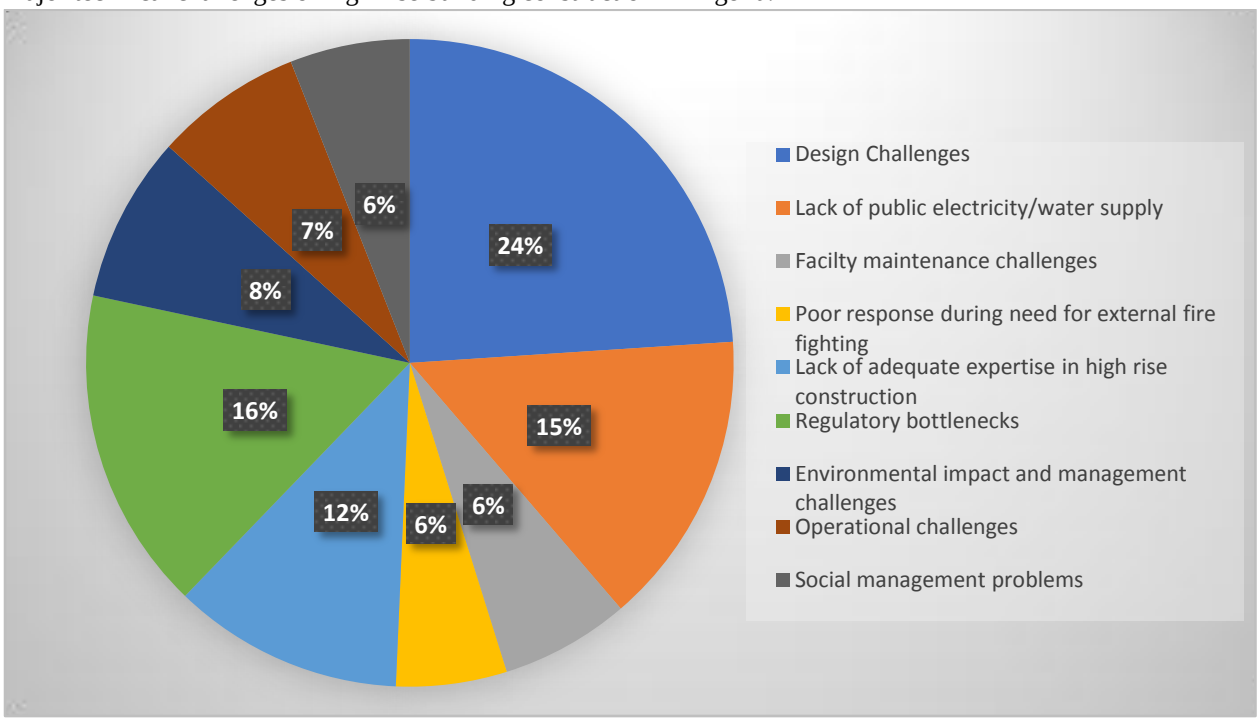


**Fig. 7**: Major Challenges of High-Rise Building Construction in Nigeria

Design challenges such as soil investigation activities, design to counter natural challenges like wind and earthquakes, Mechanical& Electrical design analysis, etc was highlighted by stakeholders in the built environment as one of the major challenges affecting high rise building construction in Nigeria. In this category, 3 factors achieved severity indices ranges of 82 -86%. This presents a relatively high degree of influence. Also, lack of public supply of electricity and water for use in these buildings posed a serious challenge as majority of the high-rise buildings in Nigeria operate with self-generated electricity and water and this has drastically

increased the running costs of this building infrastructure. This factor demonstrates effectively high severity indices of 61 -74%. This explains that this factor has an extensive degree of influence on the overall functionality of these buildings. Regulatory bottlenecks such as difficulty in obtaining approvals from regulatory agencies and local regulations in the country also challenges the development of these vertical structures. Four factors were outlined in this group. The severity indices range is between 75 – 84%. Also, over 60% and above of the respondents strongly agreed with the need to streamline approval processes, update building codes and promote collaborative governance.Governmental policies which are usually very dynamic sometimes also act as a setback which hinder the development of some building infrastructure and this leads to the proliferation of uncompleted building constructions in the country. The severity index range for this category was 55 – 61%. Some of these structures especially the ones that have been in existence for a while was without any form of regular structural integrity checks which may lead to serious forms of accidents and probably collapse if allowed to continue. This category has 3 factors. Two of these factors attained severity indices between 46 – 55%. Moreso, the lack of adequate skilled manpower during the construction of these buildings has consistently been another challenge to the development of these structures and this has resulted in the fact that most of the contracts for the construction of high-rise buildings in Nigeria are being given to international construction firms such as VKS Engineering. Severity indices for this group were between 81 – 87% which indicated a very high influence of this challenge on the design and development of high-rise buildings in Nigeria.

*4.3 Safety Concerns in High Rise Building Construction*

Table 4.1 highlights several safety concerns as regards high-rise building construction in Nigeria. These safety factors include structural collapse, fall from height, emotional stress, fear and anxiety and exposed electrical wires. This safety factors also pose a as a challenge in the construction of these buildings because it usually leads to accidents or near misses which can cause projects delays due to loss of manpower and resources.

Table 4.1: Safety factors in High Rise Building Construction

| S/N | Safety Factors | Percentage Occurrence (%) |
|---|---|---|
| 1. | Fall from height | 45 |
| 2. | Fear and Anxiety | 75 |
| 3. | Structural collapse | 35 |
| 4. | Improper safety-net system | 25 |
| 5. | Improper scaffolding | 20 |
| 6. | Exposed electrical wires | 33 |
| 7. | Unprotected shaft or holes | 46 |
| 8. | Excessive noise from Equipment | 55 |
| 9. | Exposed sharp edges of reinforcing bars | 42 |
| 10. | Fall of heavy objects from height | 67 |

- Fall from height: This accounts for a considerable number of deaths and accidents that occur during building construction. Workers falling from height is a serious safety concern in the construction of these vertical structures.
- Fear and Anxiety: Employees usually encounter some level of fear and anxiety when working at such high elevations. This results in some form of discomfort especially when the correct personal protective equipment is not provided.
- Improper Scaffolding: Observations had shown that some scaffolds used for the construction of these high-rise structures are without fall protection. This can lead to serious harm or injuries on workers if accidents occur.
- Unprotected shaft or holes: Openings in floors and shafts which are left open without any protection pose serious hazards which can cause accidents in these construction sites.
- Exposed electrical wires: Electrical wires used during the building construction which are not properly insulated may cause serious electrical hazards and may even lead to fire accidents with considerable loss of lives and man hours.
- Exposed sharp edges of reinforcing bars: Edges of reinforcement bars which are exposed in these work sites may cause injury to workers during construction or transportation.
- Fall of heavy objects from height: Fall of heavy objects such as tools, ladder, shafts, and bars from height may cause harm to workers especially if not adequately kitted with the correct personal protective equipment.

- Improper Safety net system: Safety net systems are usually provided during the construction of high-rise buildings to prevent people from intruding into the construction site.

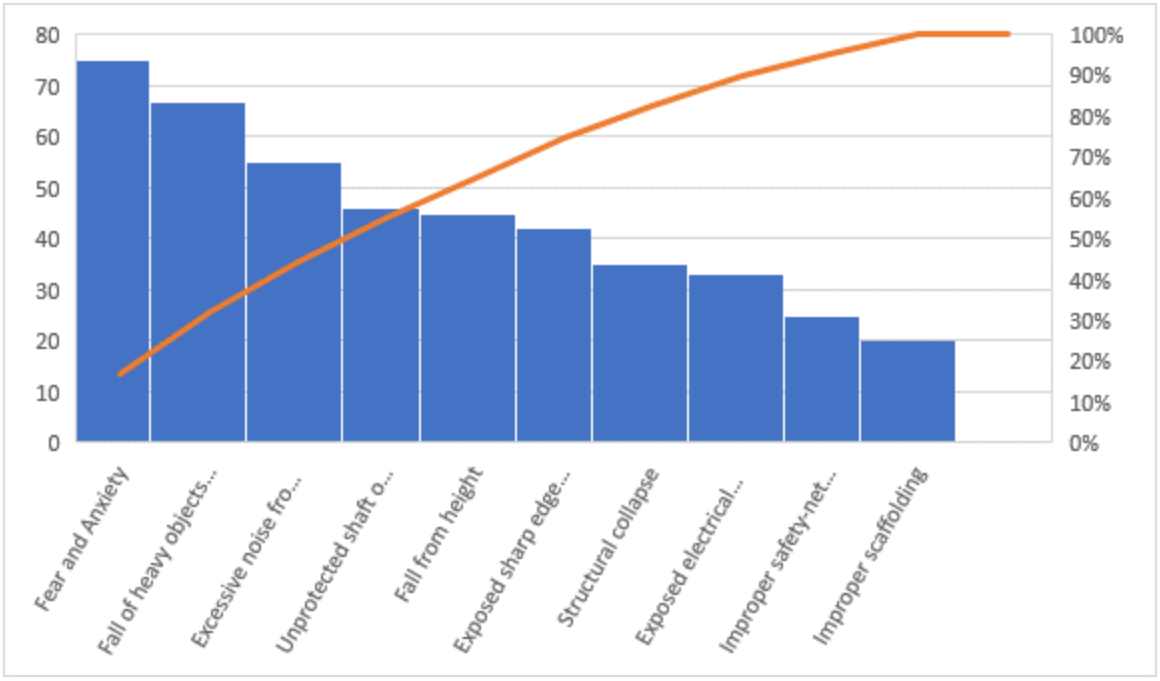


**Fig. 8:**Safety factors in High Rise Building Construction.

## V. Conclusions

This research paper has examined the prospects and challenges of high-rise buildings in Nigeria, providing valuable insights into the implications of vertical development in the country's urban landscape. The key findings can be summarized as follows:

Prospects:
- High-rise buildings offer increased housing capacity, addressing the demand for affordable housing in urban areas with limited land availability.
- They optimize land use by maximizing the vertical dimension, preserving valuable land for other purposes and promoting sustainable urban planning.
- High-rise developments can contribute to economic growth, generating employment opportunities, attracting investments, and providing commercial spaces for businesses.
- They have the potential for sustainable urban development by incorporating energy-efficient systems, efficient water management, and promoting compact urban forms.

Challenges:
- Infrastructural limitations, such as inadequate power supply, and water management, pose significant challenges for high-rise buildings.
- Regulatory frameworks and bureaucratic hurdles can hinder the development of high-rise projects, requiring streamlined processes and clearer guidelines.
- Natural challenges such as wind disturbance, earthquakes, etc also affect the structural integrity of these buildings and hence they must be designed to counter them.
- Environmental challenges, including waste management and energy consumption, need to be addressed to ensure the sustainability of high-rise buildings.
- High-rise buildings should be adequately designed to minimize the W.W.R in order to enable better energy savings.

To maximize the benefits of high-rise construction in Nigeria, it is crucial to address these challenges and implement effective strategies. Recommendations include:
- Improving infrastructure, including transportation networks, power supply, and water management systems.
- Enhancing regulatory frameworks by streamlining approval processes, updating building codes, and promoting collaborative governance.

- Adopting sustainable design and construction practices, such as energy-efficient systems, waste management strategies, and incorporation of green spaces.

- Fostering community engagement through public participation, provision of social infrastructure, and consideration of cultural preservation.By implementing these strategies, Nigeria can overcome the challenges and leverage the prospects of high-rise buildings to achieve sustainable urban development, economic growth, and improved quality of life for its residents.It is important for policymakers, urban planners, developers, and communities to work collaboratively towards creating an enabling environment for high-rise development. This requires a holistic approach that considers infrastructure, regulations, sustainability, and community needs.In conclusion, high-rise buildings in Nigeria have the potential to address housing demands, optimize land use, and contribute to economic growth. However, addressing infrastructural limitations, improving regulatory frameworks, adopting sustainable practices, and engaging communities are essential for their successful implementation. By doing so, Nigeria can maximize the benefits and navigate the challenges of high-rise construction, paving the way for a sustainable and prosperous urban future.

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